1. The method of implanting boron ions into semiconductor materials at specified energies, said method comprising

providing a source of boron ions or boron ion plasma where said ions or plasma originate from solid boron material, and wherein said plasma is defined as a state of matter in consisting of ionized cores and free electrons with approximate overall charge neutrality in space,

and streaming said ions or plasma against a target semiconductor material and thereby implanting them because of energetics suitable for penetration into the material.

2. The method of claim 1 wherein said boron ions are produced and provided by a plasma plume generated from an electrode of solid and pure boron.

3. The method of claim 1 wherein said boron ions or plasma plume are produced and provided from a solid electrode of boron compound or boron composite material, such as boron carbide or boron-silicon.

4. A method of ion implantation doping wherein plasma is involved in virtually 100% ionized pure boron plasma, meaning no other ionized atom species and no other non-ionized gas atoms in the plasma source.

5. A method of ion implantation doping wherein a plasma is 100% ionized and consists only or boron ions and ions of other atomic species that have organized in a boron composite or boron compound electrode.

6. The method as in claim 1 wherein said plasma plume is generated by a two-electrode vacuum arc system, known as a cathodic arc system.

7. The method of claim 6 wherein the plasma plume emerges from an arc generated in a vacuum space between two electrodes by application of a suitable voltage between the electrodes with possible application of arc triggering techniques.

8. The methods as in claim 2 wherein the electrode arc system is operated in either a continuous or pulsed mode.

9. A method of streaming boron ions onto a target in which the total ion arrival rate or ion implantation rate, expressed as a total electric current impinging on the target material, is at least 0.3 amps or greater.

10. The method of claim 1 in which the technique of streaming the ions onto the target uses the principle of *plasma source ion implantation* which means that the target is biased relative to the plasma potential so that boron ions are extracted directly to the target from the plasma across the p*lasma sheath.*

11. The method of claim 1 in which the boron ions are directed to the target by the technique of beam extraction from the plasma and then transport of said beam to the target over distances much larger than the plasma sheath.

12. The method of claim 1 which also includes a way to eliminate macroparticles from the ion stream so as to limit or eliminate impingement or macroparticles onto the target.

13. The method of claim 1 which includes a way or providing for uniform impingement of boron ions with area on the treated surface for targets of various sizes and up to 30 cm. in diameter or greater.

14. The method of claim 1 wherein the target is a silicon wafer or based upon a silicon wafer.

15. The method of claim 1 wherein the target is diamond or contains diamond semiconductor material.

16. The method of claim 1 wherein the target is silicon carbide or contains silicon carbide semiconducting material.

17. The method of claim 1 wherein the target is germanium or contains germanium semiconductor material.

18. The method of claim 1 wherein the boron ion energies are in the range from 0.2eV (electron volts) to 300 keV.

19. The method of claim 1 wherein the boron ion doses and energies, together with any subsequent treatments, are designed to produce the result known as "p-doping" of the silicon or other semiconductor material.

20. The method of claim 1 wherein the specified boron ion energy is selected in the range of 100 eV to 2 keV in order to result in the process known as "shallow junction doping" for which p-doping is also implied for shallow junctions.

21. The method of claim 2 wherein the solid electrode from which the

plasma originates has been synthesized by use of rf induction heating.

22. The method of claim 2 wherein the solid electrode from which the plasma originates has been synthesized by use of direct current heating.

23. The method of claim 2 wherein the solid electrode from which the plasma originates has been synthesized by use of a microwave heating at a broad range of frequencies.

24. The method of claim 2 wherein the solid electrode from which the plasma originates has been synthesized by chemical precipitation.

25. The method of claim 2 wherein the solid electrode from which the plasma originates has been synthesized by use of pressure assisted sintering with heat.

26. The method of claim 6 wherein there is an arc in the vacuum space between the electrodes, and the firing and timing of the arc is stimulated by a triggering technique such as laser firing, an external electron gun or inducing a spark.

27. The method of claim 6 wherein there is an arc in the vacuum space between the electrodes and the firing and timing of the arc is stimulated by a

triggering techniques such as laser firing and external electron gun or inducing a spark.

28. The method of ion implantation of boron, wherein every process including steps of providing for generation of plasma and streaming of boron ions to the target are conducted with all components in a vacuum.

29. The method of claim 28 wherein the vacuum precludes deliberate introduction any non-solid matter, in particular gaseous matter, other than the plasma and ions originating in the solid electrode.

30. The method of claim 1 wherein a gas my be deliberately introduced into the stream of ions or plasma, possibly in the vicinity of the target, to provide for collisions with boron ions to help randomize the incident ion directions, produce a compound by reaction in the system, to reduce target sputtering by backscattering sputtered atoms, to produce cleaning of the target surface or the like.

31. A boron ion implantation system which provides for a near-normal entry direction of the incident ions by acceleration across a plasma sheath in the plasma immersion implantation mode, wherein normal entry is facilitated by the absence of gas atoms and plasma ions of other atomic

species with which collisions of the boron ions would provide deflection of said boron ions.

32. A process of plasma immersion or plasma source ion implantation, as in claim 19, wherein the plasma that the target is exposed to is of 100% boron atomic content and of a plasma density up to $10^{12}/cm^3$ of boron ions.

33. A method of ioin implantation of boron into semiconductor silicon in which the target is amorphized at boron doses normally used for p-doping due to the extraordinary damage rate associated with the high temperature rate.

34. A method of ion implantation of semiconductor silicon with boron wherein the target may be deliberately heated to a desired temperature by the implantation process due to the extraordinary rate of heat deposition resulting from the high rate of ion deposition.

35. The method of claim 1 which includes providing the necessary cooling or attenuating the implantation rate, as desired, to achieve the desired low temperature during implantation.

36. The method of claim 1 wherein the ions are first generated and then transported to the target by beam techniques in which the boron atoms are

separated from the electrons of the plasma by electrostatic acceleration.

37. A method of ion implantation of boron into semiconductor material wherein there is neither a magnet provided nor magnetic separation of ions into atomic or isotopic species by mass analysis, nor are there any other ions or atoms co-implanted or impinging on the target surface as part of the process.

38. The method of claim 1 wherein the beam or plasma may be deflected, steered, or confined by magnets or magnetic fields of various geometries for the purpose of containment of plasma, directing the beam to the particular target, or separation of ions from macroparticles.

39. A method of providing boron ions for implantation into semiconductors by beam or plasma immersion and which requires no toxic carcinogenic, flammable, pyrophoric or explosive feed material of any kind, in particular, gaseous material.

40. The method of claim 1 wherein said beam has one or more ion species added from one or more separate ion sources for purposes of growing compounds or growing semiconductor materials with the p-dopant grown in.

41. The method of claim 1 wherein the beam is electrostatically deflected for separation of the beam from macroparticles and including the further step of mechanically trapping the macroparticles.

42. The method of claim 41 wherein the beam, after separation from the macroparticles, has its energy changed before impinging on the target surface.

43. The method of claim 42 wherein the plasma is reconstituted after a slowing down or lowering of energy of the beam.

44. The method as in claim 43, wherein the reconstituted plasma is applied to the surface by the plasma immersion technique.

45. The method of claqim 1 wherein the energy of deposition of the boron is so low as to result in a coating instead of an implantation p-doping of the target.

46. An integrated system for generating and streaming boron ions to the target for implantation by the plasma immersion technique wherein said

system comprises

acathode or vacuum arc subsystem for generation of a plasma plume,

elements of magnetic containment by electromagnets and permanent magnets for directing and expanding the plasma to a chamber large enough to accommodate the water,

mechanical barriers and traps for removing the macroparticles from the plasma, while allowing the atomic plasma to stream to the target, and

means of biasing the target relative to the plasma for extraction of said ions across the plasma sheath, according to the plasma immersion ion implantation process.

47. An integrated beam system for generating and streaming boron ions to a target wherein said system comprises:

a cathodic arc or vacuum subsystem for generation of plasma plume having a set of extraction apertures and an acceleration gap for

acceleration of beam, wherein acceleration also provides one stage of macroparticle filtering due to the macroparticles having a charge opposite from said boron ions,

an electrostatic deflection system for steering the beam away from the macroparticles, and

means for energy adjustment after the separation,

whereby the beam is impinged upon the target by known techniques for achievement of uniformity.

48. An integrated system design as in claim 47, wherein the next to final energy adjustment is a strong decrease in energy which causes the beam to "blow-up" or expand and for which the plasma is simultaneously reconstituted by addition of electrons and for which the plasma immersion technique is then applied as a final adjustment of the energy for extraction of the ions to the target, as in claim 46.